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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 09/669,732 | 09/26/2000 | Tetsuro Nakasugi | 04329.2439 | 5628 |

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FINNEGAN, HENDERSON, FARABOW, GARRETT &
DUNNER LLP
1300 I STREET, NW
WASHINGTON, DC 20006

| EXAMINER | |
|---|---|
| JOHNSTON, PHILLIP A | |
| **ART UNIT** | **PAPER NUMBER** |
| 2881 | |

DATE MAILED: 10/09/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

| Office Action Summary | Applicati n N . | Applicant(s) |
|---|---|---|
| | 09/669,732 | NAKASUGI ET AL. |
| | Examiner | Art Unit |
| | Phillip A Johnston | 2881 |

-- The MAILING DATE of this c mmunication appears n the cover sheet with th c rresp ndenc address --

**Period f r Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disp sition of Claims**

4)☒ Claim(s) 1-22 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-22 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 26 September 2000 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

### *D tail d Action*

### *Specification*

1. The disclosure is objected to because of the following informalities: Page 9, line 7, "FIG. 10" should be "FIG. 13"; page 9, line 15,"amount" should be "emission efficiency"; page 27, line 21, "decreases" should be "decreasing"; page 27, ~~line 23, "detector 107." should be "detector 107 (not shown).~~ ".

Appropriate correction is required.

### *Drawings*

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "162" has been used in Figure 17 to designate both first and second beam radiation area's. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

### *Claims Rejection – 35 U.S.C. 103*

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No.6, 344,750, to Lo in view of Eilings, U.S. Patent No. RE37, 560, in further view of Ausschnitt, U. S. Patent No. 6,128,089, and in still further view of Hosono, U.S. Patent No. 5,093,572.

Regarding Claims 1-4, Lo, discloses a pattern imaging apparatus suitable for inspection of patterned semiconductor wafers. Tool 10 includes an electron-optical column 12, an X-Y stage 14, and a vacuum-chamber 16. Electron-optical column 12 has an electron beam source 18. The primary beam landing energy is adjustable, for example in the range from 500 eV to 1.5 keV. Beam current at a specimen or wafer 22 mounted on a wafer chuck 24 is adjustable, such as with an electron beam condenser lens 26 and a beam limiting aperture. Objective lens 34 is equipped with an "in-the-lens" electron flood gun 36 and a flood beam bending electrode 38 that allows fast multiplexing between a broad, high-current electron flood beam for pre-charging wafer 22 and its conductors and a low voltage, high-resolution primary imaging beam for fast imaging. Secondary electrons are generated at the surface of wafer 22 by raster-scanning the primary beam over the surface. The secondary electrons, are detected by an electron detector 42, which supplies a signal used to form an image of the scanned region of the specimen. The bias voltage applied to wafer chuck 24 is effectively applied to the substrate of wafer 22. Pattern imaging apparatus10 reduces or eliminates the problems associated with the retarding fields that result from surface charge build up, by pre-charging an area 100, surrounding image area 96 prior to imaging image area 96. See Column 5,

line 63-67, Column 6, line 1-55, and Column 9, line 48-57. It is implied herein, that the pre-charging and imaging procedures of the Lo invention is equivalent to the "first scan procedure and second scan procedure", as recited in Claim 3. In addition, pre-charging area 100 removes the negative charges, which were deposited during previous image acquisitions, thereby eliminating or reducing the strength of the retarding field. The apparatus includes an image processing subsystem 56, which carries out data processing for image alignment and image comparison, constituting the "charged particle beam exposure section for effecting an alignment exposure of a desired pattern", as recited in Claim 4. Image processing subsystem 56 forms part of image capture processing electronics 80, which also includes an electron optical column controller 82, a video digitizer 84, a mechanical stage controller 86, an interferometer controller 88 for mechanical stage position and beam position feedback, a video output stage 90 for supplying an image signal to control computer 60 for display, and a real-time control computer 92 having a real-time operating system. Image processing subsystem 56 can be programmed to execute a range of conventional image processing algorithms including but not limited to: cell-to-cell comparison for memories; die-to-die comparison or die-to-reference for random logic; and feature-based comparison for contacts and other layers. See Column 8, line 7-47. It is implied herein, that since image processing subsystem 56 uses the stage controller 86 to position the patterned substrate relative to the Electron-optical column 12, the Lo invention can be utilized to "rearrange the secondary electron detection signals in association with the scan positions", as well as "a pattern position determining section for determine a

pattern position on the basis of image information", as recited in Claims 1 and 4. Lo further teaches optimizing parameters of the beam to improve a resulting voltage contrast image, where optimizing the beam's parameters includes generating a performance matrix. The performance matrix indicates the time required to scan or charge the pre-charge area and the resulting voltage contrast quality, for each pre-charge area size and dose ranging from the minimum to the maximum. In generating the performance matrix, numerous other "influential" parameters affecting surface charging should be considered in conjunction with adjusting scan areas 96 and 100. These parameters include beam energy, beam current, spot size (e.g., by de-focusing the beam), scan direction relative to the circuit pattern, and charge control module (e.g., wafer chuck bias voltage, charge control plate bias voltage, and energy filter voltage). It is also implied herein, that since Lo teaches a method of optimizing image quality by varying scan direction and other parameters, could include "selecting the scan positions at random according to the scan order", as recited in Claim 2, as well as, first and second beam scans having "both loci are reverse to each other", as recited in Claim 3. See Column 11, line 8-67. As described above, Lo discloses a pattern observation apparatus that includes nearly all the limitations of Claims 1-4, but does not teach the use of a table in which scan order is associated with scan positions. Eilings; however, discloses a scan control system for scanning probe microscopes that utilizes a look-up table which relates scan position parameters to scan voltage, and scan size parameters. See Column 8, line 45-67. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the pattern

imaging apparatus of Lo with the scan control look-up table of Eilings to provide definitive parametric control of beam scan position, thereby improving image resolution and repeatability of the Lo invention, leading to improved throughput and image quality, which Lo recognizes as expected features to be gained from modifying the Lo apparatus and method with the Eilings scan control technique.

Regarding Claim 5, Lo in view of Eilings, as applied to claims 1-4 above, discloses a pattern-imaging apparatus that includes nearly all the limitations of Claim 5, but does not teach the use of first and second marks formed in and on a surface of a substrate for an alignment exposure reference. Ausschnitt; however, discloses a bar-in-bar array target for measurement of critical dimensions on a substrate formed by a lithographic process containing elements deposited on two different levels whose relative center positions are sensitive to exposure and etch conditions, such that critical dimension and overlay data can be obtained from the same target. On one level, an otherwise conventional inner target portion 272 comprises inner bar set 272a, 272b, 272c and 272d aligned in a rectangular (square) pattern such that spaced parallel bar pairs 272a, 272c are aligned in the X-direction and spaced parallel bar pairs 272b, 272d are aligned in the Y-direction. On a different lithographic level, above or below the inner target portion, an outer target portion 278 comprises opposing pairs of outer bar subsets 278a, 278b, 278c and 278d aligned in a similar, but larger, rectangular (square) pattern. The outer target portion is configured such that opposing bar subset pairs 278a, 278c are aligned in the X-direction and opposing bar subset pairs 278b, 278d are aligned in the Y-direction. The bar subsets may or may not contrast with the substrate of a, located

on the first and second layers of the substrate. .performing of corrective action process control to adjust parameters. See Column 38, line 30-53. Therefore it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the pattern imaging apparatus of Lo in view of Eilings with the alignment target and method of Ausschnitt, to provide greater precision of image alignment, and more rapid determination of pattern location deviation from nominal, which improves control of the lithography process, thereby increasing production throughput and lowering cost.

Regarding Claims 6-10, Lo in view of Eilings, and in further view of Ausschnitt, as applied to claims 1-5 above, discloses a pattern imaging apparatus that includes nearly all the limitations of Claims 6-10. Lo further teaches that a solution to the continuous charge of the surface potential is to pre-charge area 100 in between successive images of image area 96. Tool 10 can multiplex between scanning pre-charge area 100 and image area 96, to generate multiple images of image area 96. In addition, both beams in the Lo invention are composed of the same beam source, electron-optical column 12 and electron beam source 18. However, Lo in view of Eilings, and in further view of Ausschnitt does not teach the use of first and second beam radiation sections composed of different beam sources in Claim 8. Hosono still further discloses a scanning electron microscope for cross section observation that comprises an SEM column 100, an FIB column 200 and a sample chamber 300. SEM column 100 includes an electron gun 1 for generating an electron beam, and FIB column 200 comprises a liquid metal ion source for generating an ion beam. See Column 4, line 37-55. Therefore it would have been obvious to one having ordinary skill in the art at the time

the invention was made to modify the pattern imaging apparatus of Lo in view of Eilings, in further view of Ausschnitt with the dual beam source apparatus of Hosono to provide still further control of beam parameters and thereby potentially improving image quality and optimization still further.

Regarding Claims 11-22, Lo in view of Eilings, in further view of Ausschnitt, and in still further view of Hosono as applied above to Claims 1-10, discloses a pattern imaging method that includes all the limitations of Claims 11-22. Lo still further teaches a method of optimizing image quality and throughput by adjusting the variables (parameters) that affect surface charging. Optimizing charged particle beam inspection tool 10 includes creating a performance matrix for the tool and selecting those parameters, which maximize voltage contrast quality and throughput. For example, by adjusting scan area 100 and electron dose, the voltage contrast of an image and the tool's throughput (e.g., the speed of image acquisition) can be optimized. It should be noted that the electron dose may also be increased by increasing the beam without impacting throughput. In the first step, tool 10 acquires an image of a small region of the patterned substrate or wafer. Next, the operator evaluates the voltage contrast by increasing the size of pre-charge area 100 from image area 96 until improvement in the voltage contrast image becomes negligible. At this point the dose density of the beam in pre-charge area 100 is too low to effectively erase the charges in pre-charge area 100. The operator then increases the dose of beam, while maintaining the size of pre-charge area 100 constant, until further improvement in the voltage contrast image becomes negligible. When pre-charge area 100 is large, the operator may choose to

select a large spot size to make sure the entire area is irradiated (instead of just narrow scan lines). Increasing the dose of the pre-charge beam includes increasing the beam current and/or the scan time (i.e., the time that the beam is on). In this example, it should be noted that current is assumed to be constant. These first two steps are repeated until the voltage contrast no longer improves, and the maximum pre-charge area size and dose are recorded. The maximum pre-charge area size and dose indicate the upper limits for achieving the best voltage contrast image. See Column 10, line 35-64. Once the maximum and minimum pre-charge area sizes and doses are obtained, the operator generates a performance matrix. In generating the performance matrix, numerous other "influential" parameters affecting surface charging should be considered in conjunction with adjusting scan areas 96 and 100. These parameters include beam energy, beam current, spot size (e.g., by de-focusing the beam), scan direction relative to the circuit pattern, and charge control module (e.g., wafer chuck bias voltage, charge control plate bias voltage, and energy filter voltage). In addition, Lo describes a procedure for simplifying image quality optimization, wherein, the operator varies one of the above-mentioned parameters at a time, examines the contrast and selects the value, which provides good contrast between the different circuits. The operator repeats this process for each of the parameters. The resulting set of values is used as a base line. The operator also ranks the parameters in terms of their influence on the voltage contrast. Next, the operator optimizes the voltage contrast quality by integrating the performance matrix procedures into the "influential" parameter (e.g., beam energy, beam current, etc.) tuning procedures. The operator generates a

performance matrix starting from the base line parameters. If none of the contrast qualities in the matrix is satisfactory, the operator should choose the performance matrix parameters that produce the best results. The operator then tunes the parameter that was previously identified as the most influential in the "influential" list. After setting this parameter to the value, which gives the best result, the operator will need to repeat these procedures for the next most influential parameter from the list. The operator may need to iterate these procedures for several parameters before the most satisfactory parameters are found. See Column 11, line 8-67.

### *Conclusion*

4. Any inquiry concerning this communication or earlier communications should be directed to Phillip Johnston whose telephone number is (703) 305-7022. The examiner can normally be reached on Monday-Friday from 8:00 am to 5:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiners supervisor John Lee can be reached at (703) 308-4116. The fax phone numbers are (703) 308-2864 and (703) 308-7721.

PJ
September 10, 2002

JOHN R. LEE
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800